1. An o-ring monitoring device for a vacuum system comprising:

a piezoelectric element with a pair of ends for externally connecting to a signal processor;

said piezoelectric element disposed and placed to be fully insulated within a mold cavity, said mold cavity having a predetermined diameter and cross-section shape;

said mold cavity filled with an elastic material encapsulating said piezoelectric element therein.

2. The monitoring device of claim 1 wherein a voltage "q" is generated as feedback to said signal processor, said voltage "q" is proportional to the amount of applied force "F_q", is given as;

$$q = [I]\chi_i F_q$$

where $[I]\chi_i$ is the piezoelectric constant.

3. The monitoring device of claim 1 wherein said piezoelectric element is selected from the group consisting of quartz, rochelle salt, barium titanate, lead zirconate, and lead titanate.

4. The monitoring device of claim 1 wherein said elastic material is selected from the group consisting of all rubber compounds used for sealing applications.

5. The sealing device of claim 1 wherein said conducting charge collectors

attached on opposite sides of said oblong cross-section are used to provide a reading of seal compression.

6. The sealing device of claim 1 wherein circumferentially encapsulating said piezoelectric element within an o-ring provides real-time monitoring of o-ring performance during ultra-high vacuum operations.

7. The sealing device of claim 6 wherein said real-time monitoring of o-ring performance eliminates lengthy maintenance problem-solving studies, most importantly, early detection precludes product waste, shortens debug time, and increases machine utilization.

8. The sealing device of claim 6 wherein said real-time monitoring of an o-ring performance eliminates back-tracking to find product defects caused by undetected o-ring failure.

9. A vacuum system comprising an o-ring sealing device.

said o-ring sealing device having a piezoelectric element molded therein;

said piezoelectric element having a pair of lead wires that egress from an outer and side periphery of said o-ring;

said o-ring sealing device placed in an o-ring groove and compressed between two surfaces;

said pair of lead wires connected to a signal processor.

10. The o-ring sealing device according to claim 9 wherein said compression between two flanged surfaces generate a feedback voltage value "q" to said signal processor, said feedback voltage is proportional to the amount of compressive force "F_q", is given as;

$$q = [I]\chi_i F_q$$

where $[I]\chi_i$ is the piezoelectric constant.

11. The o-ring sealing device according to claim 10 wherein "q" stabilizes after a desired vacuum level is reached, any variance thereafter signifies a change in compressive force "F_q", indicating a warning of a potential leak or of a defective o-ring.

12. The o-ring sealing device according to claim 9 wherein a plurality of o-ring sealing devices used in a vacuum system simplifies maintenance debug by immediately indicating the position of a defective o-ring by providing a feedback signal indicating a specific o-ring failure during the vacuum process.

13. The o-ring sealing device according to claim 12 wherein said plurality of o-ring sealing devices used in a vacuum system eliminates the otherwise time consuming search for a defective seal which causes a high number of defects before it is identified as being defective.

14. A method for monitoring compression stability of an o-ring seal during vacuum operations, comprising the steps of:

providing an o-ring seal with a piezoelectric element encapsulated

therein;

said piezoelectric element with a pair of ends for externally connecting to a signal processor;

said piezoelectric element placed within a mold cavity of a predetermined diameter and cross-section shape;

said mold cavity filled with an elastic material for molding an o-ring having a fully encapsulated and insulated piezoelectric element;

curing said molded o-ring, and

placing said molded o-ring with an encapsulated piezoelectric element in an o-ring groove for sealing a vacuum chamber;

connecting said pair of ends of said conducting charge collectors to a signal processor for monitoring compression stability of said o-ring.

15. The method of claim 14 wherein a voltage "q" is generated as feedback to said signal processor, said voltage "q" is proportional to the amount of applied force "F_q", is given as;

$$q = [I]\chi_i F_q$$

where $[I]\chi_i$ is the piezoelectric constant.

16. The method of claim 14 wherein said piezoelectric element is selected from the group consisting of quartz, rochelle salt, barium titanate, lead zirconate, and lead titanate.

17. The method of claim 14 wherein said elastic material is selected from the group consisting of all rubber compounds used for sealing applications.

18. The method of claim 14 wherein said conducting charge collectors attached on opposite sides of said oblong cross-sectional shape are used to provide an output value of seal compression.

19. The method of claim 14 wherein said piezoelectric element that is encapsulated within an o-ring provides real-time monitoring of an o-ring's performance during vacuum operations.

20. The method of claim 19 wherein said real-time monitoring to determine o-ring performance eliminates lengthy problem-solving studies while early detection precludes product waste, shortens debug time and increases machine utilization.

21. The method of claim 19 wherein said real-time monitoring for o-ring performance eliminates back-tracking to find product defects caused by undetected o-ring failure.